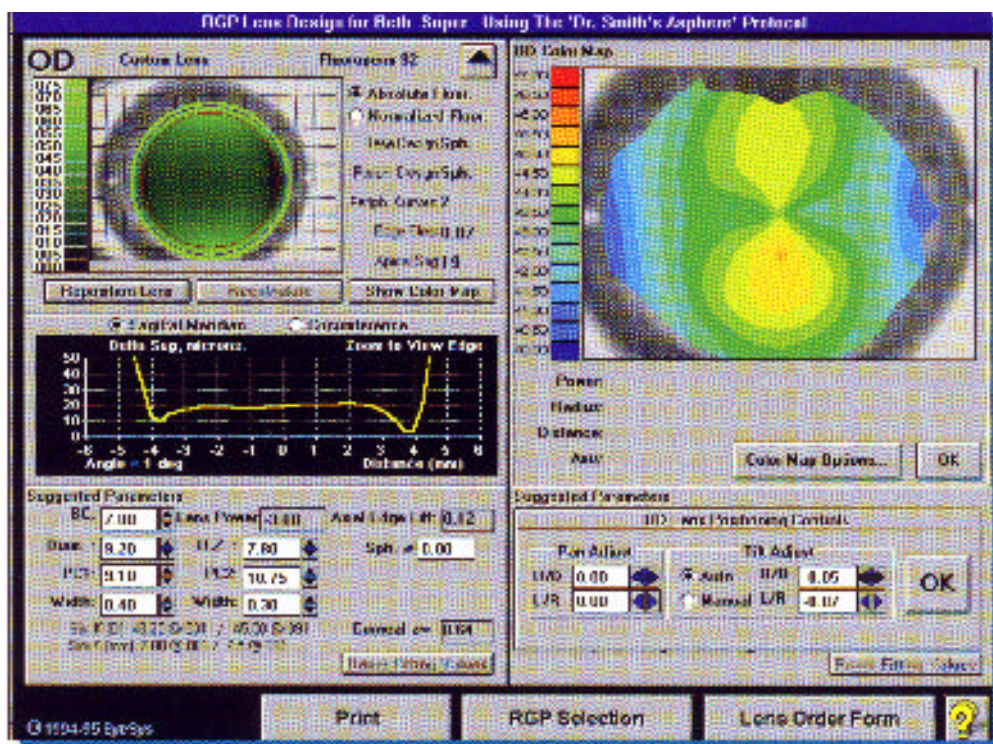


# A Comprehensive Guide to Fitting Contact Lenses with EyeSys Pro-Fit™ Contact Lens Fitting Software



by

Beth A. Soper, COA, NCLC

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EyeSys System 2000  
Version 4.0

**We wish to thank Linda J. Rhodes, H.F.C.L.S.A.  
for her contributions to this contact lens fitting guide.**

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## Introduction

For decades, many contact lens fitters have recognized the importance of determining and defining the corneal surface of their patients, but have been unable to do so for lack of proper instrumentation. To achieve "the perfect fit," more knowledge of the cornea is needed than what one can glean from central and peripheral keratometric readings using manual or automatic keratometers. In the past, designing contact lenses using methods and nomograms based on K readings has been a process of necessity. With the arrival of corneal topography, our knowledge of the cornea has greatly increased, along with our methods for designing contact lenses.

**Pro-Fit™**, EyeSys' new contact lens fitting software, enables clinicians to fit RGP lenses using topographical data, and provides access to the most comprehensive soft and soft toric contact lens data base available today. Predicted residual astigmatism is calculated for each lens type, and these calculations are displayed to assist in selecting the lens to best fit your patients.

Contributing elements that affect the positioning of the contact lens such as tear dynamics, lid tension and asymmetric topography are factors that currently are not taken into consideration. However, with the ability to replicate the actual position of the contact lens on the cornea using the Pan and Tilt features of this program, and by viewing the simulated fluorescein pattern displays, clinician time for refits and patient adaptation time is reduced to a minimum.

**Note: The fitting methods utilized in the 4.0 version of Pro-Fit™ have been developed to be used with NORMAL EYES. Special applications for Keratoconus, Penetrating Keratoplasty, post refractive surgery, abnormal corneal curvatures due to trauma and symmetric astigmatism greater than three diopters will be discussed at the end of this guide.**

## Accessing Pro-Fit™

Videokeratograph images must first be acquired before accessing Pro-Fit™. When using previously saved exams, the patient's name must first be selected from the patient locator screen. Highlight the exams to be used for fitting, then click on the Display button. Click on the Contact Lens button to begin the fitting process.

**Note: Contact lens fitting may be performed for either one or both eyes simultaneously.**

## Acquiring eye images to be used for CL fitting purposes

Proper placement and positioning of the patient before the system is required before acquisition of the eye image. Adjust the table so that it is comfortable for the patient. Put the patient's forehead on the forehead strap, his chin all the way in the chin-rest, and turn his head slightly in the opposite direction of the eye being examined. This allows maximization of the data acquired. The patient should be looking directly at the fixation light, and should be asked to blink before the image is captured. Once the image is acquired, **care should be taken to properly edit the images of any limbal lines or artifacts.** Failure to do so may cause the software to calculate very flat RGP lens base curves, as limbal lines create a 'false' flat periphery. **Note: Please refer to your EyeSys User's Manual for instructions on editing eye images.**

## Adjusting the view of the simulated fluorescein pattern

Initial display of simulated fluorescein patterns can be dramatically affected by the brightness and contrast level of the monitor used with the system. We suggest after fitting a lens suggested by the software, evaluate the actual fluorescein pattern of the lens on the patient. Adjust the brightness and contrast level of your computer monitor to match more closely the appearance of the actual fluorescein pattern to that of the simulated fluorescein display. This will ensure that the brightness of the display will match the actual brightness for subsequent exams, provided that no additional adjustment is made to the monitor brightness level.

## When trial lenses are recommended

The **presence of irregular astigmatism** may cause RGP **power** calculations to be somewhat inaccurate. Sphero-cylindrical refractions obtained for these patients usually do not accurately reflect the best corrected visual acuity. Best-corrected visual acuity is best obtained by fitting an RGP lens, then performing an over refraction. **Therefore, we strongly recommend the use of trial lenses and overrefractions to calculate final parameters for these patients.**

## Saving the contact lens fitting information

Contact lens fitting information is not saved in this version (4.0). We suggest printing the order form and making note of the refraction and eye images used. Saving and accessing patient history and contact lens information will be available in a future version.

## How to set up a fitting protocol

The basis of this software program is such that all clinicians may customize their own fitting preferences (or protocol 'defaults') to use throughout the program. To design a protocol, click on the 'Protocol' button located at the bottom of the **Patient Evaluation** screen (see Figure 1).

The first step is to give the new protocol a name. We suggest using the doctor or clinician's name, and the type of RGP lens to be designed. Pro-Fit includes five back surface designs from which to select. Aspheric or spherical base curves can be paired with spherical or aspheric peripheral curves. The design selected will be applied to all custom designed lenses utilizing this particular protocol. For example: Doctor Smith likes to use an aspheric back surface design for some of his patients. Type in the name 'Dr. Smith's Asphere' in the box next to the label 'Fitting Protocol.' Next, click on the selection 'Aspheric Base/ with 1 Aspheric Peripheral Curve. Using the sample fluorescein pattern in the area entitled 'Lens / Cornea Relationship,' establish the desired sagittal depth for this protocol. The software will recommend RGP lens parameters based on these preferences and the lens design. This is accomplished through an iterative process where the system calculates the base curve of the optical zone until the desired sagittal depth is achieved between the front surface of the cornea and the back surface of the contact lens. For example, Dr. Smith wants a 20-micron vault for his aspheric lens design. Click on the arrow in the 'steeper' direction until you reach the number 20. Click on 'Recalculate Fluorescein' to see the amount of fluorescein created by this vaulting effect. Selecting 10-15 microns of rear tear layer approximates an Alignment or parallel fit, whereas 18 - 22 microns will display an Apical Clearance fitting technique. The range you may select from is 0 - 60 microns.

Clicking on the left or 'flatter' arrow will decrease the sagittal depth, while clicking on the right or 'steeper' arrow increases the sagittal depth. The slide bar can also be moved (achieving the same effect) by clicking on the bar and holding the left mouse button until reaching the desired position. **Note: 12 microns of sagittal tear depth creates an approximate one-half Diopter tear lens, and 25 microns creates an approximate one Diopter tear lens.**

Refractions may be entered in either minus or plus cylinder format. Should the clinician choose to enter refractions in plus cylinder notation, the software will automatically convert each entered Rx to minus cylinder format, standard for contact lens prescriptions calculations. RGP curvature display is indicated by selecting either Radius or Diopter. Custom and Manufacturer Lens Preferences can be designated in the Lens Default area. Diameters for lens designs will be calculated by selecting either a constant diameter or designated by using a formula of millimeters subtracted from the HVID (Horizontal visible Diameter). Your preference for custom lens RGP materials can be assigned in the drop down menu under the heading "Custom RGP". Select a Constant Diameter for use in this protocol. Next select a stock or manufacturer's RGP lens design, as well as the choice of diameter preference. **Note: All Default setups are easily changed in several of the RGP fitting screens.** Click on 'Save' at the bottom of the screen to add a new protocol to the protocol selection list.

To delete a previously saved protocol, highlight the protocol name, and click on the 'Delete' button at the bottom of the screen. Click on the 'Patient Evaluation' button to begin the fitting process.

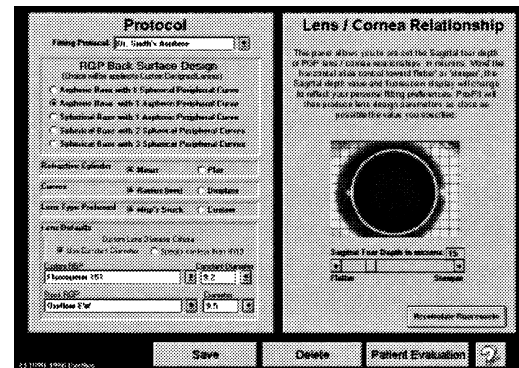


Figure 1

## How to use the Patient Evaluation screen

A fitting protocol must first be selected before further information can be entered. Keratometric and corneal eccentricity information displayed is derived from the topography data of the eye image exam selected for the fitting process.

Type in the patient's refraction that will be used for the contact lens power calculation (see Figure 2). Remember, if plus cylinder was indicated for use in the protocol, the refraction will be entered in plus cylinder format. However, the software will convert all plus cylinder refractions to minus cylinder format, standard for contact lens prescription calculations for final power calculations. This conversion takes place after exiting the Patient Evaluation screen. It is not necessary to enter the + (plus) or - (minus) sign between the spherical component and the cylinder component. Vertex distance should also be selected when compensation for the spherical component is necessary. **The software will default to 12 mm of vertex distance for power calculations, if one is not selected.** Visible Iris diameter measurement may also be entered, however **this value is not used for any contact lens parameter computations. The software will default to 12 mm VID.**

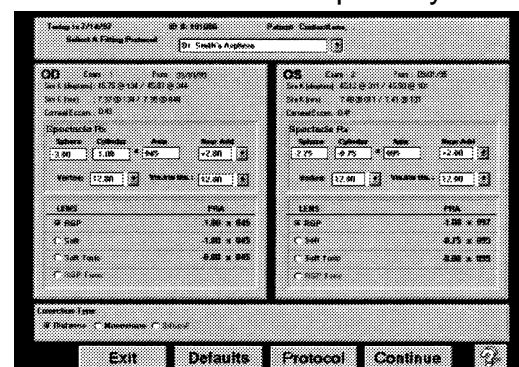


Figure 2



A unique feature of this software is calculation of Predicted Residual Astigmatism. Predicted Residual Astigmatism (or PRA) is the amount of uncorrected astigmatism that may be present for a certain lens type. This calculation is based upon the patient's spectacle refraction, corneal toricity and a lens' ability to correct astigmatic errors.

The software will also calculate changes in power for monovision fits (see Figure 3). Monovision is the practice of fitting one eye with a power that corrects for distance vision, and one eye that is corrected for the patient's reading vision. This is used for patients who normally wear bifocal spectacles, and have chosen not to wear bifocal contact lenses. Select a power for the 'Near Add' (or reading lens) and notice the box that appears at the bottom of the screen. Indicate if the powers for the lenses are to be calculated for distance vision in both eyes, or monovision. Next select which eye is to be used for the reading or 'near' lens. The clinician should decide if the full reading power (or 100%) is to be used for final power calculations, or if a smaller percentage of the 'near' power is to be considered.

Spherical soft, soft toric, and RGP lens information can be accessed in this program. The best fit for each patient is a lens that has a low or zero PRA.

Figure 3 shows the 'Patient Evaluation' screen for a patient named 'Dr. Smith's Patient'. It displays data for both eyes (OD and OS). For OD, the Spectacle Rx is Sph: -1.00, Cyl: 0.00, Axis: 180, Near Add: +2.00. For OS, the Spectacle Rx is Sph: -1.00, Cyl: 0.00, Axis: 180, Near Add: +2.00. The Contact Rx section shows Sph: -1.00, Cyl: 0.00, Axis: 180, Near Add: +2.00. The screen also includes buttons for 'Exit', 'Defaults', 'Protocol', and 'Continue'.

Figure 3

Figure 4 shows the 'Patient Evaluation' screen for a patient named 'Dr. Smith's Patient'. It displays data for both eyes (OD and OS). For OD, the Material is 'Hemisphere 1', Color is 'Clear', and Diameter is 14.0. For OS, the Material is 'Hemisphere 1', Color is 'Clear', and Diameter is 14.0. The screen also includes buttons for 'Patient Evaluation' and 'Fluorescein Display'.

Figure 4

## How to use Pro-Fit™ to fit an RGP lens

After selecting a Protocol and entering refraction information on the **Patient Evaluation** screen, click on the radio buttons next to 'RGP' on both the right and left sides. Click on 'Continue' at the bottom of the screen. The software will now take you to the RGP Selection screen (see Figure 5).

A wide variety of RGP fitting philosophies can be encompassed by designating sagittal tear depth and over-all lens diameter. Corneal eccentricity as well as central corneal radius information is used to design a lens relative to each patient's unique topography, while maintaining the fitter's preferred lens/cornea relationship specified in his fitting protocol. The fitter need only to select the diameter of the lens to view the results of the fit reflected in the simulated fluorescein display. Custom designed lens peripheral curves will achieve as close to a .08 mm corneal edge clearance as allowed by each patient's unique topographical information. Various manufacturers' RGP lens designs can also be accessed in this new program (see Figure 5). These designs are composed of proprietary information supplied by the manufacturer that has been incorporated in the software, but which we are not permitted to disclose to the general public. The software applies the same iterative process for calculating the base curve, but only selects **from the manufacturers' available base curves**. The manufacturer's peripheral curve system is utilized to create the simulated fluorescein display.

Figure 5 shows the 'Patient Evaluation' screen for a patient named 'Dr. Smith's Patient'. It displays data for both eyes (OD and OS). For OD, the Material is 'Hemisphere 1', Color is 'Clear', and Diameter is 14.0. For OS, the Material is 'Hemisphere 1', Color is 'Clear', and Diameter is 14.0. The screen also includes buttons for 'Patient Evaluation' and 'Fluorescein Display'.

Figure 5

To further illustrate this unique feature of Pro-Fit™, we will fit the left eyes of two patients with a custom designed RGP lens. These patients have in common almost identical K readings and very similar spectacle refractions. The difference between the two patients is that Patient #1 has a corneal eccentricity value of .54, while Patient #2 has a corneal eccentricity value of .32. We must remember that a sphere has an eccentricity or "e" value of 0.00. The human cornea is not spherical, but ellipsoidal in shape, with eccentricity values ranging from 0.00 to 1.00. The average corneal "e" value is .50. Therefore, the larger the "e" value of the cornea, the flatter that cornea is in the periphery. Thus, the cornea of Patient #1 flattens more towards the periphery than the cornea of Patient #2.

Topographical analysis and clinical evaluation reveal the following:

| Patient | Corneal Eccentricity | Spectacle Refraction | Keratometry Readings  |
|---------|----------------------|----------------------|-----------------------|
| #1      | .54                  | -4.00 - 1.25x015     | 43.37x013 / 44.62x103 |
| #2      | .32                  | -4.00 - 1.25x165     | 43.37x162 / 44.62x72  |

A spherical base curve with 2 spherical peripheral curves was the RGP custom design of choice for these patients. A 20-micron sagittal depth for desired tear film was selected to use in the fitting protocol. 9.2 mm lens diameters were chosen for both lenses. The software calculated the following parameters using the patient's topographic information, along with the criteria indicated in the fitting protocol:

| Patient | Base Curve   | Power | Diameter | Apical Sag | Peripheral Curves | Edge Clearance |
|---------|--------------|-------|----------|------------|-------------------|----------------|
| #1      | 7.72 (43.62) | -4.37 | 9.2      | 20 microns | 9.16/11.04        | .11 mm         |
| #2      | 7.64 (44.12) | -4.62 | 9.2      | 19 microns | 8.85/10.36        | .10 mm         |

In order to attain the same lens/cornea relationship for both patients, the software calculated different base and peripheral curves, designing custom lenses to fit the unique topography of these patients. Due to topographical differences and the higher eccentricity value of his cornea, Patient #1 was fit with a flatter lens than Patient #2. The program searched for the closest base curve to achieve the desired apical sag of 20 microns, resulting in what is commonly referred to as an 'on K' fit for Patient #1. The software selected a steeper base curve to achieve virtually the same lens/cornea relationship for Patient #2.

### **How to design a Custom RGP lens:**

Upon entering Pro-Fit™, select a protocol from the Patient Evaluation screen. Enter the patient's spectacle refraction, and select all other fields necessary. Choose RGP on the right and left eye information boxes. Click on the 'Continue' button on the bottom of the screen.

On the RGP Selection screen (see Figure 6), click next to 'Design a Custom Lens Based on Protocol' for both the right and left eyes. (Protocol information is noted at the bottom of the screen in an information box.) Selecting the 'Auto-Fill OU' button will fill in the default manufacturer or stock lens

information designated in your protocol. However, selection can be made independently by simply selecting a diameter, lens material and color choice. Information chosen for the right eye may be copied directly to the left eye by clicking on the OD=OS button. Clicking on the 'More Lens Detail' button will provide information concerning the material selected, as well as manufacturer information. Clicking on the individual folder tabs (Lens Info., Manufacturer Info., Additional Info., Custom Info.) displays files specific to each lens material or design. Now click on the 'Fluorescein Display' button.

Simulated fluorescein patterns and tear depth graphs are displayed for both eyes simultaneously. A grid representing 1 square millimeter divisions overlay the simulated fluorescein pattern. The scale to the left of each pattern corresponds to the amount of fluorescein (in microns) simulated for the contact lens as it would appear on the cornea. The default values for the Absolute view of the fluorescein scale are from zero to 75 microns, and have been determined to be the most realistic values for fluorescein simulation in most cases. Each eye can be enlarged or zoomed to evaluate the patterns in greater detail. Click on the button with the arrow located in the upper right hand corner of each eye to activate the 'zoom' function.

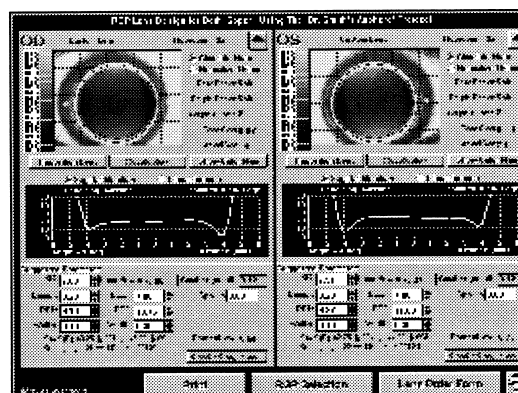


Figure 6

Reposition Lens button: Clicking on this button enables you to view the pan and tilt controls of the software (see Figure 7). Pro-Fit™ is the only software program that provides an interactive analysis with automatic or manual lens tilt as well as manual lens positioning. Replicating the actual position of the contact lens on the patient's eye image is accomplished by moving the simulated lens (as if you are facing the patient) right (+ numbers) or left (- numbers) in 0.1 mm increments. The Pan U/D enables movement of the contact lens up (+ numbers) or down (- numbers) in 0.1 mm increments to correspond with superior or inferior displacement of the contact lens. Click on the Up/Down arrows on the right hand side of each box to increase/decrease the numbers, then click on the 'OK' button to view the change in the Simulated Fluorescein Display. The Tilt controls default to 'automatic', as the system normally computes the best lens tilt angles for any Pan position. Tilt is best described in relationship to each individual's topography. A lens will tilt in the direction of the steepest part of the cornea. This function enables Pro-Fit™ to replicate simulated fluorescein patterns as they actually would appear on the patient's cornea.

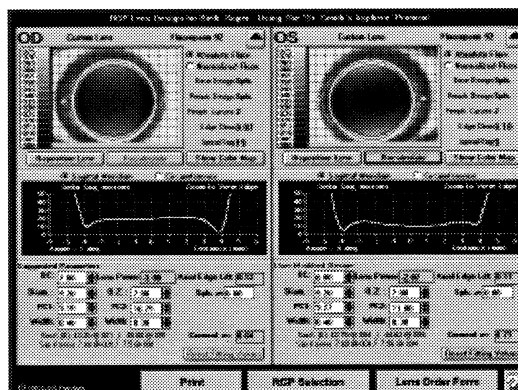


Figure 7

Recalculate button: Click on this button when changes have been made to any of the lens parameters to display a new fluorescein pattern for the modified contact lens design.

Show Color Map button: To visually correlate the patient's corneal topography and the simulated fluorescein pattern, a color map can also be viewed next to either of the fluorescein maps. Click on the 'Show Color Map' button and a normalized color map will appear (see Figure 8). Viewing the Color Map is essential when determining where the contact lens will position, once it is placed on the patient's eye.

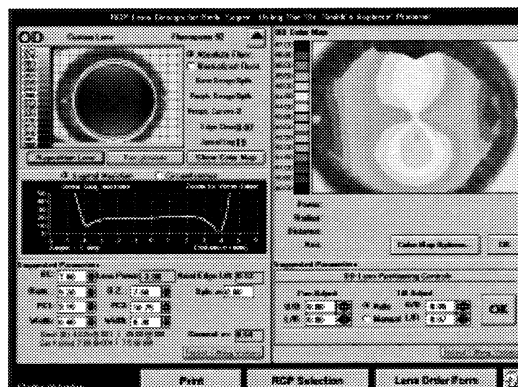


Figure 8

A contact lens will always attempt to position over the area of greatest steepening, thus moving away from a flat area of the cornea. When looking at the color map, use the Pan function to position the simulated lens over the steepest area of the cornea. The simulated fluorescein pattern will change to reflect the new position of the contact lens. Once the Color Map is displayed, the user may select to overlay different features by clicking on the 'Color Map Options' button. Click on 'OK' to close this feature.

**Sagittal Meridian and Circumference Graphs:** The Sagittal Meridian Graph initially displays the amount of tear film thickness across the flat meridian of the patient's cornea. The clinician can select any other axis to view by simply clicking the left mouse button anywhere on an axis inside the fluorescein pattern. The position of the mouse cursor is located by the angle notation located at the bottom of the graph. To view the circumference graph, click on the button next to the word 'Circumference'. The data initially displayed is at the center of the lens, thus giving the user a quick read-out of the central sagittal depth. The clinician may select any radius around which to display the amount of tear film thickness for 360 degrees by clicking on an area in the simulated fluorescein pattern with the left mouse button. The distance from center is indicated in the lower portion of the graph. When there is missing data in the periphery of the eye image, the software uses extrapolation and indicates extrapolated data points with red dots on the circumference graph.

**Suggested Parameters:** This group of controls initially displays the software suggested contact lens parameters. The controls allow modification to most of the following:

|  |   |
|--|---|
| <b>BC</b> (displayed in either diopters or millimeters): | The lens base curve   |
| <b>Lens Power</b> (Diopter):                             | The lens refractive power   |
| <b>Diam.</b> (mm):                                       | The overall lens diameter   |
| <b>O.Z.</b> (mm):  | The optic zone width  |
| <b>PC1</b> (diopters or mm):                             | The first peripheral curve curvature  |
| <b>PC2</b> (diopters or mm):                             | The second peripheral curve curvature   |
| <b>PC3</b> (diopters or mm):                             | The third peripheral curve curvature  |
| <b>Width</b> (mm):                                       | The width of the peripheral curve,<br>displayed below each curvature reading  |
| <b>Sph. e:</b>   | A display only field for the eccentricity<br>value of a spherical lens (zero)   |
| <b>Corneal e:</b>  | The eccentricity value of the patient's<br>cornea   |
| <b>Lens e:</b>   | The eccentricity value of the optic zone<br>of an aspheric contact lens   |
| <b>Axial Edge Lift:</b>                                  | A display only field for the distance<br>between the edge of the contact lens,<br>and the virtual prolongation of the<br>lense's base curve |

Modifications to most of these parameters can be done manually by clicking on the Up/Down arrows on the right hand side of each box, then clicking on the 'Recalculate' button. The simulated fluorescein display will then reflect any operator entered changes. Any change made to the base curve of the lens will automatically change the power.

**Reset Fitting Values button:** Clicking on this button restores the original parameters suggested by software to all fields, once a modification has been made.

**Print:** Clicking on this button will print a hard copy of the fluorescein screens, once the screen is exited. You may return to either the RGP Selection screen, or proceed to the Lens Order Form by clicking on the appropriate buttons located at the bottom of the screen.

Once a lens design is complete, click on the Lens Order Form to view the order or to produce a hard copy of the patient's contact lens prescription.

#### RGP Order Form:

The patient's name, ID number and today's date appear on the order form automatically (see Figure 9 on page 12). The lens parameters (determined in the Simulated Fluorescein Display) are also displayed on this form. Selections may be made for type of peripheral curve blend, center lens thickness, and special edge designs. For example: a lens that will ride high on the cornea due to an area of superior steepening (located when viewing the Color Map) may indicate the need for a prism ballast. Select 'Prism Ballast' from the Special edge design box, and notice another box ('Prism Ballast Choices') will appear below. You may specify the amount of prism to be added, from a range of .50 Diopters to 3.00 Diopters. Special lab instructions may be typed in the 'Notes' box. Dispensing information can be typed in the lower right hand box located at the bottom of this form. You may select from a list of authorized laboratories from which to order the lenses, or type in your own laboratory's name, phone and fax numbers. Laboratories that have been added will appear in the list the next time you return to this screen. The 'Ordered By' and 'Delivery' boxes can be customized for your clinic in the same manner. Click on the 'Print Order' button to print a hard copy of the order form for your patient's records, or to use to fax directly to the lab.

#### How to fit a Manufacturer's Design RGP Lens

Upon entering the contact lens fitting software, select a protocol on the Patient Evaluation screen. Enter the patient's spectacle refraction, and select all other fields necessary. Select RGP on the right and left eye information boxes. Click on the 'Continue' button on the bottom of the screen. On the **RGP Selection** screen, click next to 'Select From Manufacturer's Designs' for both the right and left eyes. Selecting the 'Auto-Fill OU' button will fill in the default manufacturer or stock lens information designated in your protocol. However, selection can be made independently by simply selecting a lens name, diameter, lens material and color choice. Selections for the right eye can be automatically transferred to the left eye by clicking on the OD=OS button. Clicking on the 'More Lens Detail' button will provide information concerning the lens you have selected, as well as manufacturer information. Clicking on the individual folder tabs (Lens Info., Manufacturer Info., Additional Info., Custom Info.) displays files specific to each lens material or design. Proceed to the simulated fluorescein display by clicking on the 'Fluorescein Display' button.

**Note: The software will select the appropriate base curve based on the sagittal depth specified in your fitting protocol, and the lens diameter selected. It does not use the manufacturers' own fitting methods or nomograms to design a lens.**

Simulated fluorescein patterns and tear depth graphs are displayed for both eyes simultaneously. A grid representing 1 square millimeter divisions overlay the simulated fluorescein pattern. The scale to the left of each pattern corresponds to the amount of fluorescein (in microns) simulated for the contact lens as it would appear on the cornea. The default values for the Absolute view of the fluorescein scale are from zero to 75 microns, and have been determined to be the most realistic values for fluorescein simulation in most cases. Each eye can be enlarged or 'zoomed' to evaluate the patterns in greater detail. Click on the button with the arrow located in the upper right hand corner of each eye to activate the 'zoom' function.

[illegible]

**Figure 9**

**Recalculate button:** Click on this button when changes have been made to any of the lens parameters to display a new fluorescein pattern for the modified contact lens design.

**Show Color Map button:** To visually correlate the patient's corneal topography and the simulated fluorescein pattern, a color map can also be viewed next to either of the fluorescein maps. Click on the 'Show Color Map' button and a normalized color map will appear. Viewing the Color Map is helpful in determining where the contact lens will position, once it is placed on the patient's eye. A contact lens will always attempt to position over the area of greatest steepening, thus moving away from a flat area of the cornea. When looking at the color map, use the Pan function to position the simulated lens over the steepest area of the cornea. The simulated fluorescein pattern will change to reflect the new position of the contact lens. Once the Color Map is displayed, the user may select to overlay different features by clicking on the 'Color Map Options' button. Click on 'OK' to close this feature.

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**Suggested Parameters:** This group of controls initially displays the software suggested contact lens parameters. The controls allow modification to some of the following:

|                                      |   |
|--------------------------------------|---|
| <b>BC</b> (diopters or millimeters): | The lens base curve   |
| <b>Lens Power</b> (Diopter):         | The lens refractive power   |
| <b>Diam.</b> (mm):                   | The overall lens diameter   |
| <b>Corneal e:</b>                    | The eccentricity value of the patient's cornea  |
| <b>Axial Edge Lift:</b>              | A display only field for the distance between the edge of the contact lens, and the virtual prolongation of the lens base curve |

The software has determined the base curve based on the sagittal depth previously specified in the fitting protocol and availability of the appropriate base curve by the manufacturer. **Note: if a base curve is not available to produce the sagittal depth specified in the fitting protocol, the software will recommend the closest base curve available from the manufacturer to produce the specified lens/cornea relationship.** Optical zone values and peripheral curve information are not displayed for manufacturer designed lenses, as this information is often proprietary and not available to the general public. The user has the option of changing the base curve of the suggested lens. You will be able to select from only the base curves available for the selected diameter. Modifications to the base curve can be achieved manually by clicking on the Up/Down arrows on the right hand side of each box, then clicking on the 'Recalculate' button. The simulated fluorescein display will then reflect any operator entered changes. Any change made to the base curve of the lens will automatically change the power

**Reset Fitting Values button:** Clicking on this button restores the original parameters suggested by software to all fields, once a modification has been made.

**Print:** Clicking on this button will print a hard copy of the fluorescein screen, once the screen is exited. You may return to either the RGP Selection screen, or proceed to the Lens Order Form by clicking on the appropriate buttons located at the bottom of the screen.

Once a lens design is complete, click on the Lens Order Form to view the order, or to produce a hard copy of the patient's contact lens prescription.

#### RGP Order Form:

The patient's name, ID number and today's date appear on the order form automatically. The lens parameters (determined in the Simulated Fluorescein Display) are also automatically displayed on this form. Special lab instructions may be typed in the 'Notes' box. Dispensing information can be typed in the lower right hand box located at the bottom of this form. You may select from a list of authorized laboratories from which to order the lenses, or type in your own laboratory's name, phone and fax numbers. Laboratories that have been added will appear in the list the next time you return to this screen. The 'Ordered By' and 'Delivery' boxes can be customized for your clinic in the same manner. Click on the 'Print Order' button to print a hard copy of the order form for your patient's records, or to use to fax directly to the lab.

## Using Pro-Fit™ to select soft spherical and soft toric lenses

Contact lens selection and ordering utilizes an extensive and comprehensive database that is updated on a regular basis. The software does NOT recommend a specific lens to best fit the patient, as there

are hundreds of lens names in the database from which to choose. The software WILL calculate a suggested power for the lens. Suggested power calculations are based on spherical equivalent formulas, vertex distance compensation, and monovision considerations. When using the software for toric lens fitting, the suggested power of the lens may not always be available for the selected lens name. We suggest ordering the CLOSEST lens parameters in this situation, or selecting another lens that may provide the exact power needed.

Upon entering **Pro-Fit™** software, select a protocol on the **Patient Evaluation** screen. Enter the patient's spectacle refraction, and select all other fields necessary. Click on either 'soft spherical' or 'soft toric' for one or both eyes. Click on the 'Continue' button at the bottom of the screen.

The contact lens database is sorted by daily wear lenses, extended/flex wear lenses, or you can choose from a combined list of lenses with various wearing options. Information located in the toric lens and spherical lens analysis box refers to previously entered refraction information, suggested power for lens selection, and simulated over refraction power calculations for the suggested power (see Figure 10).

Lenses may be selected by manufacturer, or by the lens name in alphabetical order. Selecting the lens name first will automatically fill in the manufacturer's name. The software will indicate which base curves are available for that particular lens, as well as diameter, power, and lens color information. Should you choose a lens power different from the suggested power, the software will now note this as the 'User Selected Power' and recalculate the simulated over refraction. The original suggested power can be accessed by clicking on the 'Suggested Power' button. The **Trial Fit** function can be activated for soft toric lens fitting (see Figure 11). Click on the 'Trial Fit' button, and enter the amount and orientation of rotation that is present with the trial lens you are fitting on the patient. The software will automatically recalculate the axis necessary to fit the patient. Computations based upon trial lens fitting will be highlighted in red. You must then re-select the appropriate axis in the axis field box.

To clear all fields once a selection has been made, click on the 'Reset Lens Parameters' button.

Extensive information regarding the selected lenses can be accessed by clicking on the 'Show More Lens Detail' button (see Figure 12). Lens material name, water content, oxygen permeability, and recommended disinfecting systems can be displayed by clicking on the 'Lens Info.' Folder tab at the top of the screen. Manufacturers' address, telephone numbers and customer service lines can also be referenced by clicking on the 'Manufacturer Info.' Folder tab. Most toric lenses (U.S. version only) have the manufacturer's fitting guide scanned into the database for quick and easy reference. The 'Additional Info.' Folder provides lens care recommendations, as well as noting the life expectancy of the material selected. 'Custom Info.' Displays availability of custom design parameters and all color choices for the selected lens material.

Once the lenses have been selected for both eyes, click on the 'Lens Order Form' button at the bottom of the screen.

The Soft Lens Order Form can be printed to use as an order form, and/or to insert into the patient's record (see Figure 13). Patient information is automatically printed on the form, as well as the Clinic name and address entered in the Protocol screen. The telephone and FAX numbers must be entered in the appropriate boxes at this time, also. Once this information is entered, it will become a choice for selection for future ordering. The 'Ordered By' box may be customized in the same manner. There are three pre-programmed choices in the Delivery box, however this box can be customized with your own selections, too. Notes or comments to the lab or dispenser can be typed in the 'Comments' box. Click on the 'Print Order' button for a hard copy of this form.



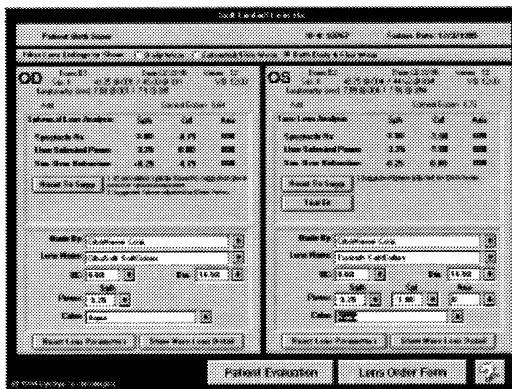


Figure 10

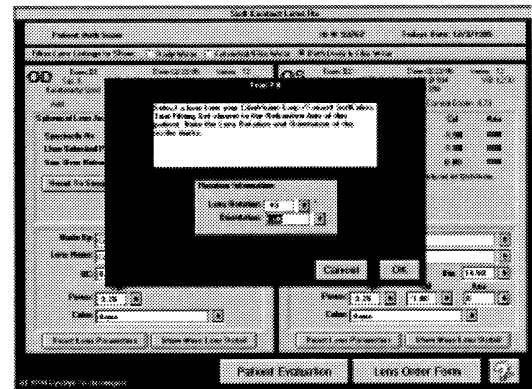


Figure 11

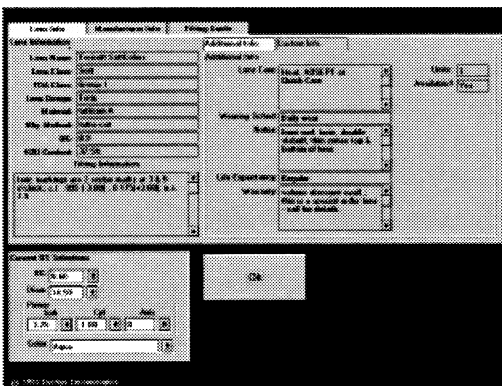


Figure 12

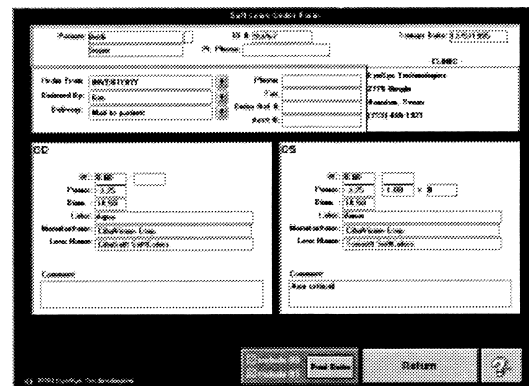


Figure 13

## Post Fitting Considerations

### Follow Up Analysis

Clinicians use several criteria for determining whether a rigid or soft contact lens is fitting properly. One of those criteria is if corneal measurements have been maintained within certain limits. Measurements taken on follow up visits that are within + (plus) or - (minus) .50 diopters of the original keratometry readings are considered acceptable when measured by keratometry. The quality of the reflected keratometry image is another measure of whether contact lenses are fitting properly. However, since the keratometer derives its measurements from a very limited area of the central optical zone of the cornea it is not necessarily the best tool for evaluating effects of contact lenses on corneal topography.

Computer assisted videokeratography provides a more comprehensive view of the cornea. Not only can the clinician determine if simulated K's at the three millimeter zone are within + (plus) or - (minus) .50 diopters of the original readings, but the clinician can compare quantitatively, readings at the three, five and seven millimeter zones by semi-meridians. By comparing post-fitting data to pre-fitting data, the clinician can determine the presence, location and degree of corneal warpage, distortion and/or apical displacement that may be caused by improperly fit contact lenses. This information along with a qualitative evaluation using the EyeSys Color Map illustrates the effect of the contact lens on the patient's corneal topography and provides a more accurate picture of corneal topography changes induced by the wearing of rigid or soft contact lenses. On each follow up visit, computerized videokeratoscopic imaging is performed and the new data is compared to the prefitting data. Most of the display screens can be used for comparative purposes.

The Difference Map display is useful in checking the cornea for changes that could be taking place from one visit to the next. This display subtracts the difference in curvature obtained from one exam from a second exam. The Difference Map is displayed using a separate normalized scale in half Diopter steps, which allows the fitter to assess areas of the cornea that have been affected by the lens. Viewing data in this manner can demonstrate that a lens may need only minor modification to the peripheral curve system, as opposed to major changes in the overall fitting method or design. Once modifications have been made to the lens, the cornea can be imaged again, and assessment made by viewing the difference Map displays.

## **Refitting the Previous Wearer**

Computerized videokeratography can play a vital role in refitting rigid contact lens wearers who have developed corneal warpage from poorly fitting rigid contact lenses. A key function of videokeratography in refitting rigid contact lenses is the system's ability to demonstrate when a cornea is stable. Serial videokeratographic images are performed on successive visits until the simulated keratometric readings are stable and the topographic color maps indicate similar scaling and patterns. Once stability has been achieved, the patient is ready to be refit. After the patient has been refit, videokeratography allows the clinician to follow and maintain a stable fit by evaluating corneal topography on subsequent visits.

It is also possible to refit rigid or soft contact lenses without discontinuing the use of lenses and waiting for the cornea to become stable. It requires the clinician to obtain keratometry measurements from a time when the patient had been without their lenses for a minimum of one to two months. This information may be obtained from the patient's original contact lens fitter, or from a subsequent fitter. (As long as the patient has been out of lenses for an extended time, the K readings can be considered relatively reliable). Once the clinician has the original K readings, videokeratographic images should be obtained. If the patient's original K readings differ from the videokeratograph K's, the base curve of the lens to be fit is calculated using the original K data. This base curve is then substituted in the Simulated Fluorescein Display screen. The simulated fluorescein pattern and sagittal vaulting effect over the patient's current topography are then evaluated. If the lens parameters produce a reasonable fluorescein pattern and vaulting effect, this lens should be ordered. If the parameters produce a poor vaulting effect, the base curve and or diameter and peripheral curve system can be altered on the Simulated Fluorescein Display screen until the desired vaulting effect is achieved. If the wearing of contact lenses has caused the K's to flatten significantly, and lenses are reordered based on the original K's, the clinician may find that the Simulated Fluorescein Display will show a tremendous increase in the sagittal values. However, in time, the patient's cornea will stabilize and this reading will become more normal.

This method of refitting may slow the cornea's ability to stabilize. To date, there are no statistically significant long term studies using computer assisted videokeratography which demonstrate the time it takes for the cornea to stabilize using this or any other refitting method. If this method is used, it would be wise to inform the patient that it may take from one month to one year for the cornea to stabilize. However, using the information from the Map displays and the patient's best-corrected acuity with a manifest refraction, the clinician can determine when corneal topography has become stable.

## Special Lens Fitting Applications

Art and science go hand in hand when it comes to fitting patients who have Keratoconus, corneal transplants, refractive surgery and other corneal irregularities due to trauma or corneal disorders. Although the EyeSys Corneal Analysis System currently does not have a contact lens fitting program to design rigid lenses for these typically very difficult cases, analyzing the data produced by the Color Maps can decrease patient chair time and reduce the number of diagnostic lenses necessary to achieve a good fit.

### **Keratoconus**

Current methods of fitting rigid contact lenses on patients with Keratoconus involve the use of standard design lenses on patients with incipient cones, and the use of either the Soper Cone, McGuire Cone or Aspheric and Bi-Aspheric lens designs on moderate to advanced cones. For any fit to be successful, the clinician must be able to identify the type, size, position and degree of advancement of the cone. Although cones can be located any where on the cornea, most begin in the inferior temporal region of the cornea. Using computer-assisted videokeratographs, the clinician can determine if a cone exists long before there are clinical signs. They can identify the shape of the cone, locate the position in relationship to the center or mid line of the cornea, determine the degree of steepening and determine where to start with diagnostic lenses.

### **Proposed Methods for Choosing Diagnostic Lenses**

Several methods have been proposed for determining how to choose the best diagnostic lens. Two of these methods are as follows:

#### Averaging Method

Using the topographic Color Map, the clinician places the cursor on the steepest area of the cone and records the radius at that point. The flattest reading of the cornea is then located and is recorded. The average of these two readings is used to select the initial diagnostic lens. For example: if the steepest reading is 56.37 diopters and the flattest reading is 42.12 Diopter, the average of these numbers is 49.25 diopters. A diagnostic lens with a 49.25 Diopter base curve is tried on the patient. If the majority of the cone is located close to the midline, a Soper Cone design lens with a base curve of 49.25 with a 43.00 Diopter flange could be tried (over all diameter 7.5 to 8.5 mm). If an aspheric lens design is tried, the clinician would select an initial diagnostic lens with a 49.25 Diopter base curve (diameter 8.0 to 8.5 mm). Usually small central cones can be fit with small diameter lenses, starting around 7.5 to 8.8 mm regardless of the lens design.

If the cone is grossly displaced, the same base curve of 49.25 diopters either in the Soper Cone design or an aspheric design should be tried first. However, the clinician will need a larger diameter (somewhere between 8.8 and 9.5 mm) and a larger optical zone to insure the patient's field of vision will be adequately covered.

## Apex Value and Size Method

A second fitting method utilizes the relative size of the cone and the degree of steepness at the apex of the cone to determine what base curve should be used for the first diagnostic lens. With this method, the cursor is placed on the steepest reading of the cone, and the reading is noted. The clinician then moves the cursor 2.5 mm laterally to the right of the cone, then 2.5 mm to the left of the cone, and records those readings (see Figure 14 on page 20). These two peripheral readings are then averaged. This average is used to select the initial diagnostic lens. For example, if the reading nasally 2.5 mm from the steepest reading on the cone is 52.50 diopters and temporally 59.62 diopters, the average is 56.00 Diopters. An initial diagnostic lens with a base curve of 56.00 diopters is tried on the patient. Again, the design of the lens and the diameter will depend on the location of the cone and its relative size. As with the previously mentioned method, the optical zone and diameter of the diagnostic lens should be sufficient to satisfy the patient's optical needs.

Either one of these methods should provide the clinician with adequate information to determine the best starting point for diagnostic lens evaluation. The initial diagnostic lens will determine whether the clinician needs to go steeper, flatter, smaller or larger. Using these methods can decrease the amount of time spent trying different diagnostic lenses and should produce more successful fits. The choice of using one type of lens design over another is up to the clinician and what they are comfortable with. In general, aspheric and Bi-aspheric cone designs work best with small central cones that are located close to the midline of the cornea, whereas the Soper Cone lens works well for almost all cones.

## Piggy Back Fitting System

On advanced and difficult to fit cones it may be necessary to fit the patient in a piggyback system. Although this type of fitting is more cumbersome and requires greater patient compliance, the rewards can be great in the form of relieving the stress over the cone, reducing the risk of corneal abrasions and increasing the visual acuity for many of these patients. A soft lens with a high DK value is first fit on the patient. Once the best soft lens has been determined and the lens is on the patient's cornea, a videokeratoscopic image is taken of the front surface of the soft lens. If the curvature findings and overall topographic findings over the soft lens are suitable, simulated K's over the soft lens are used to determine the base curve of the rigid contact lens. Particular attention should be paid to the proper fitting of the RGP lens to insure that it will move freely over the surface of the soft lens and position adequately over the patient's visual axis. If the lens does not move the effect of two lenses can cause corneal edema and decreased visual acuity.

## **Refractive Surgery**

The term refractive surgery is used here to cover all corneal surgery performed to alter the patient's cornea in an attempt to meet a particular visual need. Although there are many of these surgeries being performed everyday, not all will be successful as the surgeon or patient may want them to be. Surgical manipulation of cornea topography with a poor result can be quite challenging to the contact lens fitter

Most clinicians agree that it is best to wait at least four to six months after most refractive surgery before the fitting of contact lenses is to be considered. Once the cornea is deemed stable, fitting contact lenses on these patients can be made easier using computer assisted videokeratography. A videokeratoscopic image of the patient's cornea is first obtained. Information from the Color or Numeric Map is used to determine an initial lens for diagnostic purposes. Generally, the central three millimeters of the topography is grossly affected by the surgery, therefore data at 3 millimeters is of little value in fitting these patients. Data from the mid-periphery approximately three to four millimeters from geometric center measured by semi-meridian or the readings at the 5 mm zone on the Numeric Map

are used to determine the base curve of the diagnostic lens. For example, the radius of curvature in the center of the cornea may read 34.00 diopters, while at four millimeters from the center the reading is 44.50 diopters (see Figure 15 on page 20). In this case a 44.50 Diopter lens with a 9.0 mm diameter would be the first choice for the diagnostic contact lens. If an air bubble formed under the lens, the clinician would need to go to a flatter base curve, such as a 40.00 Diopter lens, and increase the diameter of the lens to 9.5 or 10.5 millimeters. It is necessary to use a large diameter lens when fitting this much flatter to achieve stability and the best centering.

RGP lenses will usually position over the steepest portion of the cornea. If the superior cornea demonstrates a greater area of steepening, the lens will probably want to ride up under the upper lid. If the inferior portion of the cornea has a greater area of steepening, the lens will ride low. It may be necessary to order special lens designs to help center some lenses. For lenses that ride high, a prism ballast lens may be used to help position the lens properly. If the lens rides low on the cornea, it may be necessary to use a lenticular design to lift the lens. In some cases, just going to a slightly larger diameter or steeper base curve will be sufficient to stabilize, if not center, the lens.

Several rigid contact lens manufacturers make lenses with a periphery that is steeper than the base curve. These lenses were first developed for clinicians who were attempting to fit patients using orthokeratology. This type of lens has a flatter base curve to fit the flatter central cornea and steeper periphery to fit the steeper transitional zone of the cornea.

Aspheric lenses have been used in some refractive surgery cases, however these lenses work best when the central cornea is steeper than the transitional and peripheral zone of the cornea.

The beauty of videokeratography in working with refractive surgery patients is that the clinician can easily visualize the corneal topography, which is a wonderful aid to help the clinician select the right contact lens for these patients.

## **Post Keratoplasty**

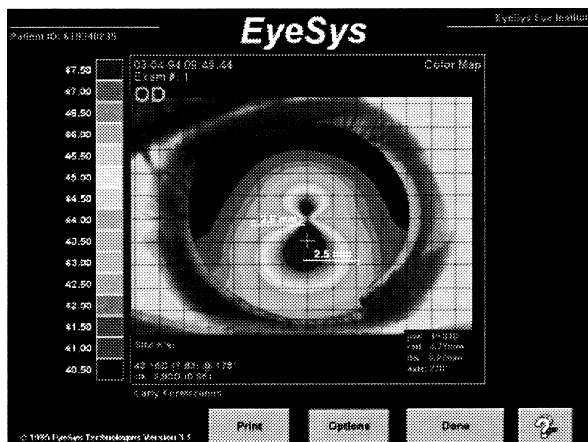
Some clinicians prefer to wait until the patient is one year to eighteen months post-op and/or after sutures have been removed before the fitting of contact lenses are initiated on a cornea transplant. Others fit lenses within one to two months with all sutures intact. Most clinicians initiate fitting around four to six months post-op, usually because the patient has become impatient with not being able to see as well as he would like to. Most post keratoplasty patients require the fitting of a rigid contact lens due to high degrees of irregular corneal astigmatism. Some have very flat grafts in relationship to steeper hosts and others have very steep grafts in relationship to grossly flatter hosts. In all of these situations, computer assisted videokeratographs are valuable tools in determining the best fit for post keratoplasty patients. Data from the simulated K readings and information from the Topographic Color Map is used to choose an initial diagnostic lens. The following chart is designed to give the clinician a starting point for choosing a diagnostic lens.

|                               |                         |                         |                         |
|-------------------------------|-------------------------|-------------------------|-------------------------|
| <b>Simulated K's:</b>         | 34.00 to 49.00 Diopters | 42.00 to 49.00 Diopters | 42.00 to 70.00 Diopters |
| <b>Suggested Base Curves:</b> | 38.00 to 40.00 Diopters | Standard Fit            | 48.00 to 60.00 Diopters |
| <b>Suggested Diameters:</b>   | 9.5 to 10.5 mm          | 9.0 to 10.5 mm          | 9.0 to 9.5 mm           |

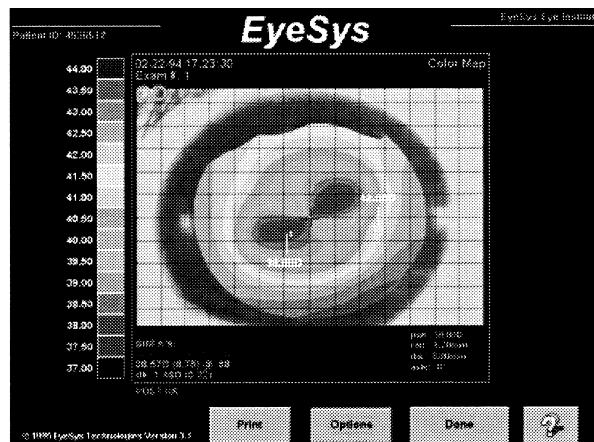
For example, if the largest area of the graft is flat with a smaller area of steepening, the clinician should choose an initial diagnostic lens with a flat base curve and a 10.0 mm diameter. If the graft measures between 42.00 diopters in the flat meridian and 44.00 diopters in the steep meridian, the patient can quite possibly be fit using standard fitting methods. It may be necessary to use a larger diameter of between 9.0 and 10.5 mm. If the greatest area of the graft is steep, a diagnostic lens with a steep base

curve such as 48.00 diopters and a diameter around 9.0 mm to 9.5 mm should be used. After performing a slit lamp evaluation of the initial diagnostic lens, the clinician will know whether to go steeper, flatter, smaller or larger and whether a special lens design will be necessary to help center and stabilize the lens over the graft.

There are several factors that affect how a lens will position and move over a corneal graft. The lens will always attempt to position over the area of greatest steepening. If the patient's cornea is steeper in the inferior temporal quadrant, the lens will position low and temporal on the cornea. In most circumstances it will be necessary to use larger diameters in the range of 9.0 to 10.5 mm as mentioned previously to help center and stabilize the lens over the patient's visual axis. The degree of steepness at the graft host junction will directly affect the way the lens positions on the cornea and will dictate which lens design is best suited for the patient. It may be necessary to order an orthokeratology type design, aspheric, lenticular, prism ballast, cone, softperm or piggyback lens design to improve the centering and movement of the lens. It should be noted that with the Softperm and/or piggyback lens designs, these lenses and lens combinations may decrease the amount of oxygen to the cornea. For some corneal transplant patients, insufficient oxygen transmission may cause graft rejection. When Softperm or piggyback lenses are used, these patients should be followed frequently. To maximize the amount of oxygen available with piggyback fitting systems, both of the lenses should have a high DK value.



**Figure 14**



**Figure 10**

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